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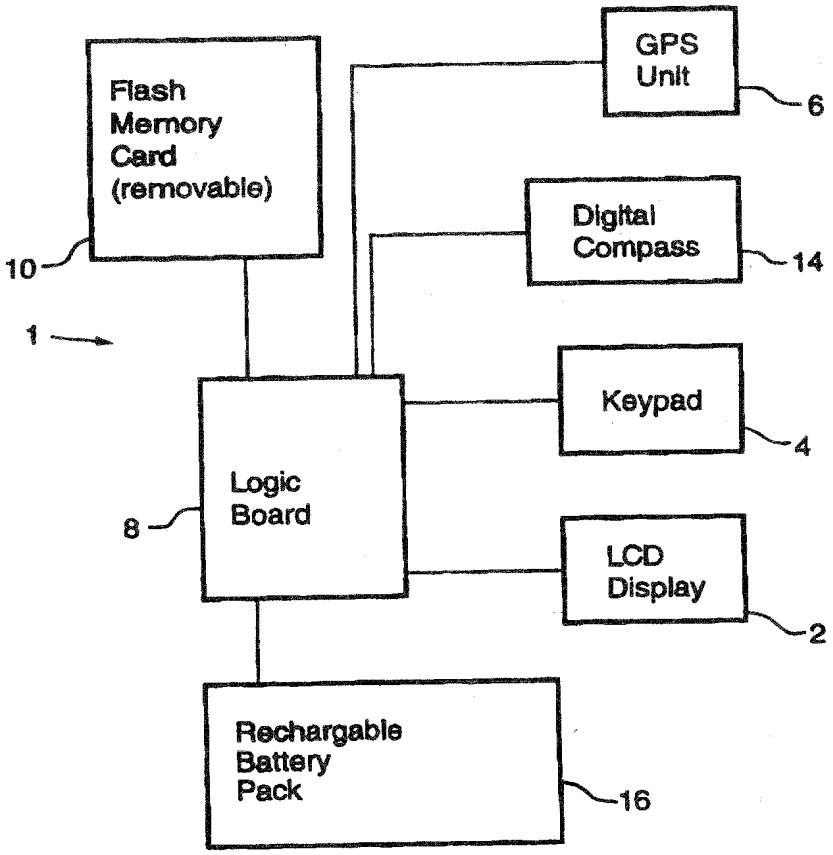
(54) Title: NAVIGATION DEVICE

(57) Abstract

The navigation device (1) displays a true image of a digitized map, and provides position information via a GPS UNIT (6). A built-in electronic compass (14) provides data to correctly orient the map display to the ground. The device receives the map image from flash memory cards or "flashcards" (10), which plug into a simple port in the device. A number of destinations, waypoints or other reference points may be stored.



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NAVIGATION DEVICE

TECHNICAL FIELD

This invention relates to navigation devices, and in particular to a compact unit which combines GPS data with map data, in a user-friendly interface.

BACKGROUND ART

There are now many prior art devices which combine GPS (global positioning system) data with map data. Examples are United States patent nos. 5,353,034; 5,343,399; 5,307,277; 5,293,163; 5,289,195; 5,189,430; 5,179,519; 5,124,924; 5,117,363; 5,089,826; 5,084,822; 4,954,959; 4,949,268; 4,912,645; 4,903,212; 4,903,211; 4,891,760; and 4,837,700.

Most of the prior art devices are for use in aircraft or land vehicles, and are intended for permanent installation in the vehicles. Most use a CD-ROM unit for map data storage, although several mention the use of an IC card or a "smart" card for storage of map data.

Many units now provide GPS data in a portable, hand-held format. Examples are units sold by Eagle Electronics, Sony, Socket Communications, Panasonic, Trimble, Icom, and Magellan.

Generally, the hand-held units do not have a map display, or if they do, it is not a full display of a "real" map. Instead, it is a collection of way points or vectors which are used to provide a "map-like" display of key features such as roads, landmarks, etc.. None of the hand-held devices known to the inventors appears to provide a display of an actual digitized map image, with all of the visual information which a good map typically provides. This impacts on user-friendliness and on the overall attractiveness of the units, and thus on effectiveness.

Also, none of the above devices appears to provide compass information of the user's orientation on the display.

DISCLOSURE OF INVENTION

In view of the above, the inventors have recognized a need for a compact, user-friendly device which would display a true map image and provide position information via a GPS unit, and display the user's orientation in relation to the map. It is an object of the invention to provide such a unit.

In its preferred embodiment, in keeping with the desire to provide a compact hand-held unit, the map data is stored on PCMCIA (Personal Computer Memory Card International Association) flash memory cards or "flashcards", which are considerably more compact than compact discs, and which do not require a bulky CD-ROM unit. These flashcards are similar in size and appearance to a common credit card, but incorporate a memory chip capable of holding up to about 80 MB of data at present, which is generally enough for the images of eight or nine conventional topographical maps, e.g. eight or nine of the USGS's 7.5 minute, 1:24000 scale quadrangle series of maps. The flashcards plug into a simple port in the device.

In the invention, the user interface is designed to be easy to use, and easy to learn. The unit can be hand held, does not require secondary paper maps or compasses, and can locate the users to within typically less than 20 meters (typical GPS Standard Positioning Service (SPS) accuracy) of their true position. Maps are displayed on a colour LCD screen, and positional information is displayed on top of the map, giving the user real-time navigation on a map of the terrain currently being traversed. When a reference point such as a destination or landmark is entered, that point is also displayed on the screen. A number of such reference points can be stored in relation to the particular map. Icons can be assigned to these reference points, and keys may be provided bearing the specific icons.

The device also includes an electronic digital compass. Information from the compass is displayed to provide orientation information for the user relative to the map display. Specifically, the cursor preferably is or includes an arrow which points north, so that the device can be rotated to correctly orient the displayed map to the ground.

BRIEF DESCRIPTION OF DRAWINGS

In order that the invention may be more clearly understood, embodiments thereof will now be described in detail by way of example, with reference to the accompanying drawings, in which:

Fig. 1 is a block diagram of the device;

Fig. 2 is a block diagram of the logic board portion of the device;

Fig. 3 is a plan view of the device in the open position;

Fig. 4 is a perspective view of the device, in the open position;

Fig. 5 is a perspective view of the device in the closed position;

Fig. 6 is a top view of the device in the closed position;

Fig. 7 is a side view of the device in the closed position;

Fig. 8 is a front view of the device in the closed position;

Fig. 9 is a view of the display, showing a small portion of a topographical map;

Fig. 10 is a view of an alternative configuration for the device;

Fig. 11 is a view of a possible novice mode grid display;

Fig. 12 is a view of a possible text display;

Fig. 13 is a view of a possible expert mode course deviation display;

Fig. 14 is a view of possible softkeys and pop-up menus;

Fig. 15 is a view of a possible novice mode user interface; and

Fig. 16 is a view of a possible data management scheme for the expert mode.

BEST MODE FOR CARRYING OUT THE INVENTION

The following description refers to the original conceptual design of the unit, as illustrated in Figs. 1-9, and to a more recent design as illustrated in Fig. 10. Where specific components are mentioned, with reference numerals, these references are with respect to the unit of Figs. 1-9. Other components not seen in Fig. 9 are generally present in the Fig. 10 unit. However, the Fig. 10 unit is also conceptual in nature, so the particular function of buttons is not critical, and can be assigned in any desired fashion to produce the functionality described herein.

The invention therefore should be considered in relation to the functionality described herein, rather than with respect to the specific embodiments which are illustrated.

Specifications of the Unit

The main components of the unit 1, and their specifications, are as follows:

(a) LCD Screen 2: A high resolution color backlit screen is provided. For portability, the viewing area of the screen preferably is in the range of 4 to 6 inches diagonally. The map display enables display of actual position, identify destination position and waypoints. The user has the option to zoom in and out on desired locations with minimum data loss (resolution) and to scroll the map north, south, east, and west.

(b) Keypad 4: A limited-use keypad is used for inputting data and scrolling through menu choices. The keypad can be used to enter destinations, waypoints or other reference points, such as a car, a building, a base camp, a favorite fishing hole, or any other desired landmark. These are memorized positions saved to the flashcard.

(c) GPS Unit 6: The GPS unit is an "off the shelf" component. Suitable units could be obtained from a number of vendors, including Rockwell, Panasonic, Trimble, and Novetel. These receivers typically provide accuracy to within less than 20 meters.

(d) Logic board 8: The logic board, shown schematically in Fig. 2, provides the following functionality:

i. reads and writes the flashcard data

ii. displays the map data on the LCD screen in color

iii. interfaces with the GPS receiver, interprets the signal, displays the co-ordinates on the LCD screen (both numerically and represented by a cursor). The cursor represents the GPS coordinates for the georeferenced map data being displayed.

iv. compares GPS-sensed position with data on flashcard and displays error message and longitude/latitude values if there is no match between the two, i.e. if the location is outside the areas covered by the flashcard

v. integrates the digital compass

vi. interfaces all components to the keypad

vii. monitors and displays on the LCD screen all component status (e.g. low battery, no signal, etc.)

viii. enables the user to store limited amounts of information to the flashcard

ix. enables the user to zoom into and out of any map as well as scroll the map across the screen

The logic card includes SRAM **81**, program ROM **82**, a CPU **83**, and FPGA based control and interface area **84**, as well as a flashcard interface **85**. The SRAM (static random access memory) is the working memory for the unit. The program ROM contains the software to implement the above functions. The CPU is a 32-bit RISC microprocessor, which minimizes power consumption and provides sufficient speed for the map display. The control and interface logic area contains support circuitry for the microprocessor and memory, power conservation and battery monitoring circuitry, interface circuitry to other parts of the system, and a hardware "serial number" (not unique to each device) for use in decrypting map data. (The maps may or may not be encrypted to guard against unauthorized use or copying.)

(e) Flashcard **10**: The flashcard is an existing product, presently in use primarily in connection with computers and personal organizers. Information stored on this flashcard is a rasterized color tiff file or encoded format. A number of fixed points **11**, geo-referenced to latitude/longitude values, are located on the map. The map data can vary greatly in size, scale and area covered. One example is a display

2500 pixels by 2500 pixels, with a map representing 20,000 ft. by 20,000 ft. (for U.S. scaled maps), such that each pixel has a dimension of 8 feet. Each map image is geo-referenced using the Universal Transverse Mercator (UTM) coordinate system, which can be based for example on NAD 83 or NAD 27, in the units of either feet or meters, using for example the GRS 80 ellipsoid. Each flash card containing map data preferably is keyed to prevent unauthorized copying of the data.

(f) Flashcard Interface **12** (connection port for the flashcard): The interface is defined by the PCMCIA standards for Type II flashcards.

(g) Digital Compass **14**: May be an existing product that can be purchased from Timex or Seiko or Casio, for example.

(h) Rechargeable Battery **16**: This may be an "off the shelf" component.

(i) Housing **18**: The housing is of rugged plastic construction, with shock-absorbing rubber mounts for internal components. The housing preferably is in two halves **19** and **20**, with a hinge **21** and a latch **22**. Rubber seals around the periphery of the two halves create an essentially waterproof compartment. The keypad and LCD screen are préferably mounted in a waterproof or water resistant manner as well, so that water cannot seep into the interior even with the housing in the open position.

Operation of the Unit

The unit operation is as follows:

1) The unit is turned on via the "on" button **30**.

2) The GPS unit locates the user, and the logic board interprets this information and displays the latitude and longitude on the LCD display.

3) Immediately after initialization, the flashcard is scanned by the logic board. If there is no flashcard installed or if the wrong flashcard is installed for the user's location, only longitude/latitude values and an error message are

displayed. The user is prompted for the proper flashcard. This message will be followed by the novice mode grid view.

4) If the correct map card is found, the device will proceed to the novice mode normal view. If the device is configured for expert mode, the initialization will be the same apart from the mode of operation.

5) When the correct map is inserted into the unit, the map image is displayed on the LCD screen. At start-up the map is oriented such that the cursor (representing actual position) is in the center of the display. The map is repositioned to return the cursor to the center, when the cursor moves near the edge of the display.

6) The device provides the user with menu driven options, selectable using buttons or keys. The user can easily toggle between the map display and the menu selection window or screen.

7) The default setting will be the novice mode. In this mode the user is able to see his or her current position, speed and direction, enter a desired destination, and know the distance and direction to the desired destination. Novice Mode: If the user presses Destination, they are provided softkeys that enable them to know the distance or direction to their desired destination as well as change their desired destination. If the user presses Change, they can select a new destination by manoeuvring a destination cursor whose co-ordinates are updated in real time at the bottom of the screen. Once the new destination is selected, the user simply presses Enter, and is returned to the previous destination menu. The user is returned back to the location menu after a short time or by pressing an escape key.

Some users will desire more advanced navigational features than will be available in the novice mode. This additional functionality is provided in the expert mode. In addition to the functionality provided in novice mode, expert mode enables the user to:

- store navigational points such as destinations and route markers plan routes, whether they are new routes or previous tracks that are modified;

- plan routes, whether they are new routes or previous tracks that are modified;
- navigate to a destination via pre-entered waypoints;
- display and store information pertaining to the route travelled;
- access indicators of course deviation.

In both novice and expert mode, the user can access on-line help.

8) The user can zoom in or out of the map image to better view the terrain detail and position, by pressing the "zoom/normal" button **34**.

9) The user will be able to use arrow keys **36** to move a floating cursor over the screen to a preferred location or destination by indicating direction of intended travel. When the cursor moves to the edge of the screen, the map scrolls to permit the cursor to keep moving relative to the map. The unit, using the digital compass, will indicate direction of travel; when displayed in conjunction with the map the user will be able to pick the best route.

10) A number of positions can be placed on the screen and labelled by a letter code or as a picture (house, car, camp), and can be stored to the flashcard for future reference. This is accomplished by using the arrow keys to move the cursor to the desired location, and then pressing one of the "icon" buttons **38**. Obviously, the icons shown in Fig. 4 are examples only; fewer or more or different icons could be used, or for that matter there is no essential requirement to use icons; numbers or letters could be used, although icons offer obvious advantages in terms of user friendliness.

11) The user can select map only, or map plus GPS. The map only selection is useful to permit the user to program the unit before setting out on the trip. To select map only, the user presses the "display map" button **40**.

12) The user can elect to have the latitude and longitude displayed, by pressing the "Lat/long" button **42**. This could be useful in situations where the users want to tell other people where they are, such as where a rescue or meeting is desired.

13) The unit will be equipped with a DC adapter or cigarette lighter adapter for optional power sources

14) The device has mode settings options which enable the user to operate in a mode that provides latitude, longitude and a default altitude (sea level) upon receipt of three satellite signals, or a 3D mode, which includes an accurate altitude reading, given receipt of four satellite signals.

15) The device illustrates actual speed and heading information along with a displayed comparison of heading with respect to an established course. The device provides time estimates to destination or waypoint based on average velocity.

16) The unit will power down after a set interval, such as four minutes for example, to reduce power consumption and to thus prolong battery life. The user may also turn the unit off, by pressing the "off" button **44**. The unit will issue a warning when battery power gets low. At that stage, full functionality may be disabled, such that only compass information or GPS information may be displayed, to reduce demands on the battery.

17) A simple compass display can be selected, so that a visual display of a compass is presented.

Novice mode

For the novice mode, two types of displays were considered for conveying the required navigational information, namely "Option 1" and "Option 2":

Option 1 is a grid display which shows the navigational information in graphical representation. This display is conceptualized in Figs. 11 and 15.

With a digitized map inserted into the device, the grid display provides three views:

1. a grid view which provides a cursor that shows the location of the user and the map district in which the user is positioned
2. a normal (1:1) view which provides cursor that shows the location of the user and the immediate terrain
3. a zoomed out (1:4) view which provides a cursor that shows the location of the user and four times more of the surrounding terrain than seen in the normal view

Option 2 is a text and grid display, which additionally presents the navigation information in a textual format as shown in Fig. 12. This display is accessible with or without a digital map card.

Option 1 has been selected as the preferred embodiment, since it offers two main advantages: it provides an incentive for users to purchase digitized map because map data is required to unleash the full potential of the device; and it follows the guiding philosophy that the device should be as graphical and as intuitive as possible.

Expert mode

As previously discussed, the primary difference between novice mode and expert mode is the need to manage routes and navigation points. The user interface concept is illustrated in Fig. 16.

In addition to the data management menus, the expert mode involves changes to the softkey menus. These differences are highlighted in Fig. 17.

For the expert mode, the two types of displays that were considered for novice mode were considered again, as well as a third type of display, namely Option 3, a Course Deviation display which has a graphical indicator to show any course deviation. This indicator is illustrated in Fig. 13. The preferred embodiment thus includes options 1 and 3.

For both the novice and expert mode, two types of menu system were considered, namely Option 1 (Softkeys and Pop-Up Menus), and Option 2 (Pop-Up Menus).

Softkeys are physical keys that when pressed, activate the feature that has been associated with them. The rationale for using softkeys is that they limit the number of keystrokes that the user must perform to invoke the desired feature. Their main drawback is that without another user interface, it is difficult to present a logical functional hierarchy. To overcome this drawback, a combination of both softkeys and pop-up menus is provided in the preferred embodiment, as conceptualized in Fig. 14.

A pop-up menu interface is simpler than developing both a softkey and pop menu interface. Also, a pop-up menu interface has the benefit of not being tied to any physical keys, and hence is very modular by nature. The main drawback of this alternative is the relatively high number of keystrokes that are required to access the most basic functions.

In the novice mode, only softkeys will be used. The main benefit is that users who only want to perform basic navigation functions will not have to understand an involved menu system. They will simply press the respected softkey for the feature they want to invoke. For the expert mode, both types of interface will be employed. The use of pop-up menus is required because managing navigation points and routes requires more user input than can be easily provided with just softkeys by themselves.

Set-Up Mode

Set-up mode has a user interface that is similar to data management scheme discussed in the expert mode sub-section.

INDUSTRIAL APPLICABILITY

The invention provides a GPS-based navigation device which displays a digitized map image.

CLAIMS:

1. A navigation device, comprising a display screen, a GPS unit, a logic board, a map data receiving port, a battery pack, and an electronic compass, operatively connected to each other within a housing assembly such that:

digitized map data received at said map data receiving port is displayed as a visual map image on said display screen;

position information received from said GPS unit is displayed on said map image at the correct location; and

data from said compass may be displayed on said map image to permit orientation of the device to the ground, by rotating the device to align the display in accordance with the compass information.

2. A navigation device as recited in claim 1, further comprising a keypad for inputting reference points on said map, for moving a cursor on said display, for scrolling the map data past the map window, and for changing the scale of the map to zoom in or zoom out.

3. A navigation device as recited in claim 1, where said logic board provides the device with the following minimum functions:

a. reads the map data via the map data receiving port;

b. displays the map data on the display screen;

c. interfaces with the GPS receiver, compares the GPS data to the map data, and displays an error message if the position indicated by the GPS unit is not within the boundaries of the map; and

d. displays the digital compass data to facilitate orienting the map correctly to the ground.

4. A navigation device as recited in claim 1, where said map data receiving port is configured to receive map data from flashcards.

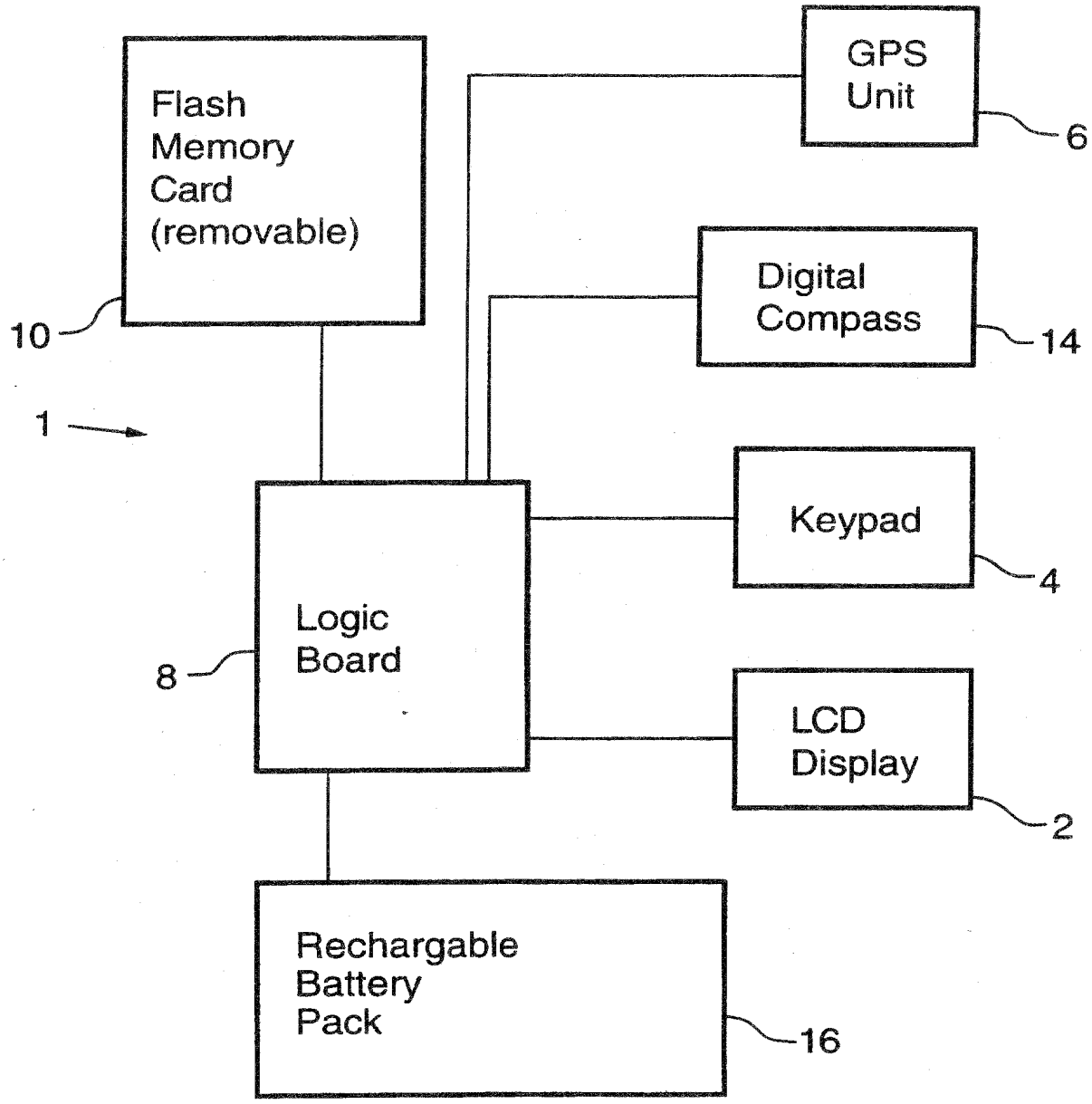

FIG.1

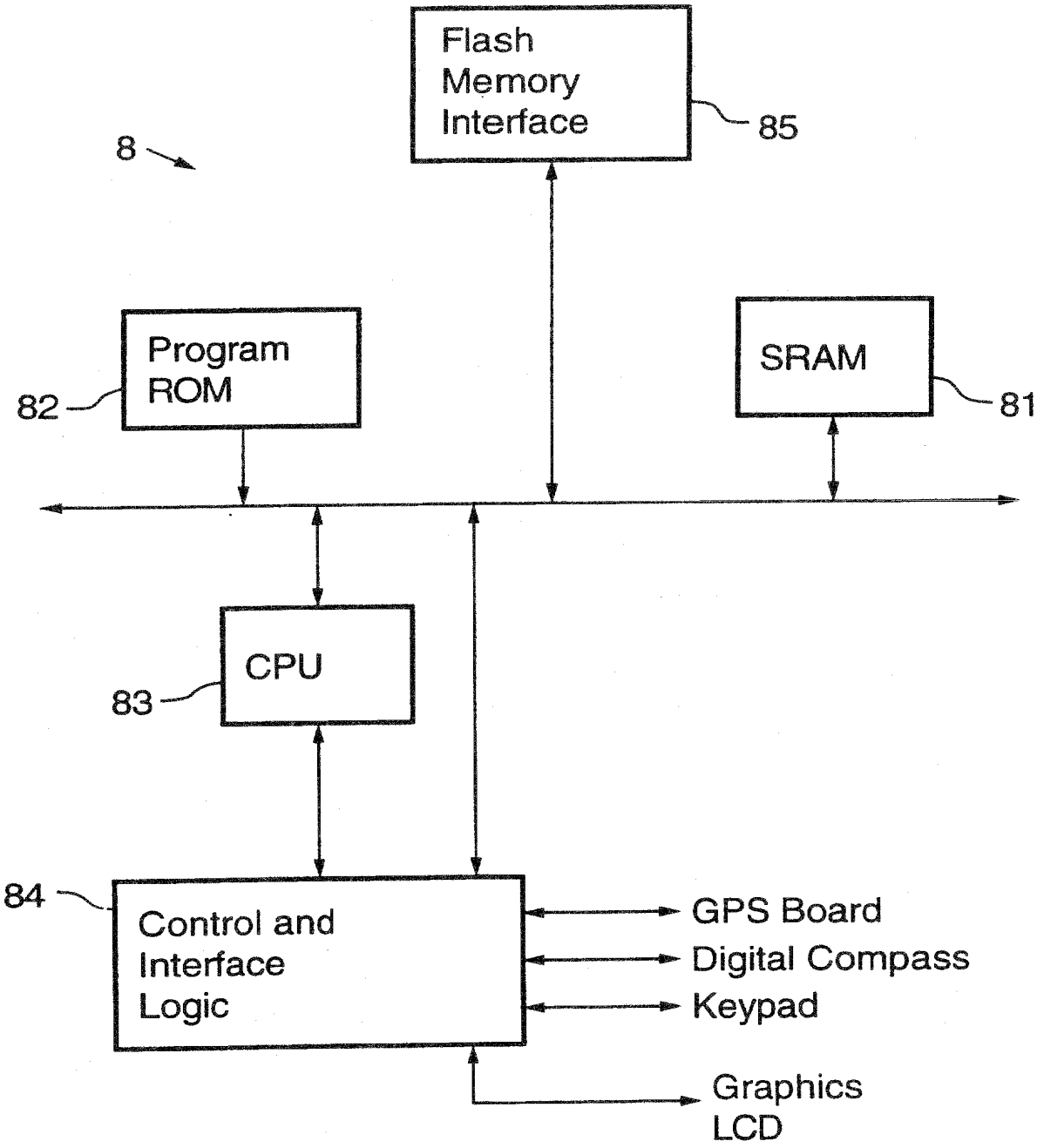

FIG.2

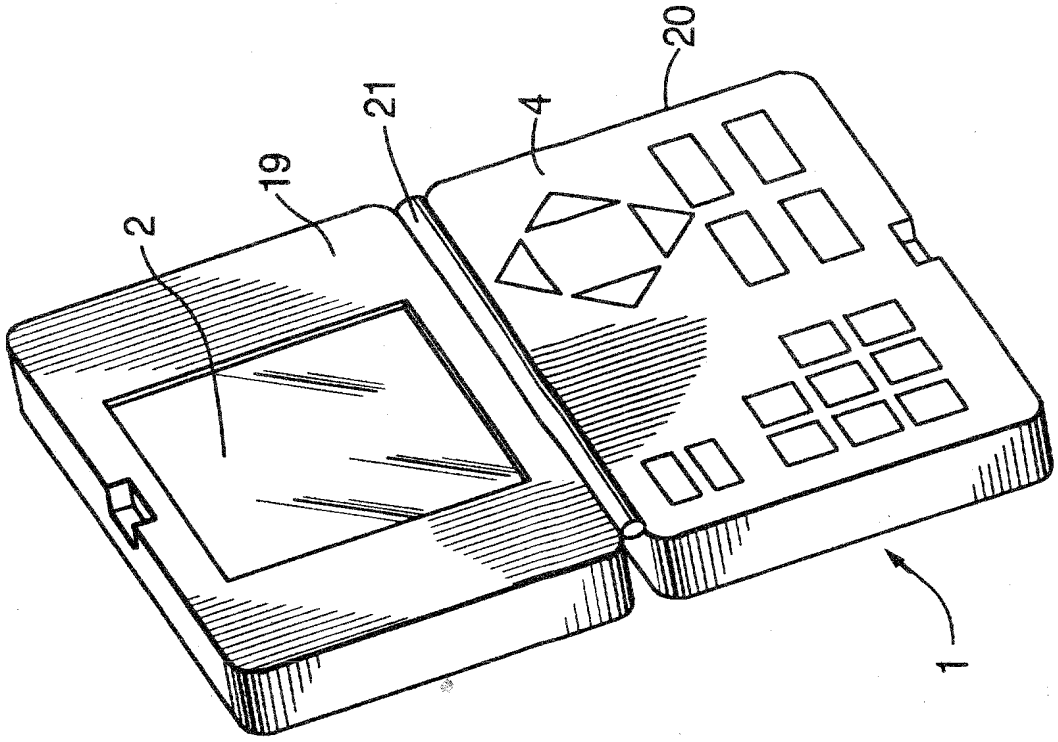

FIG.4

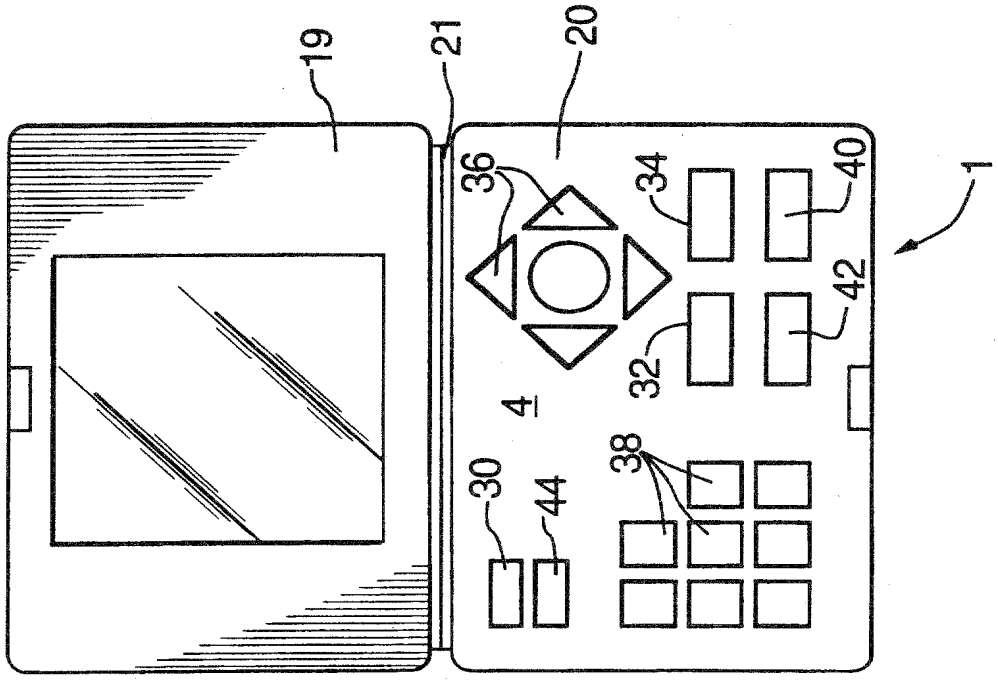

FIG.3

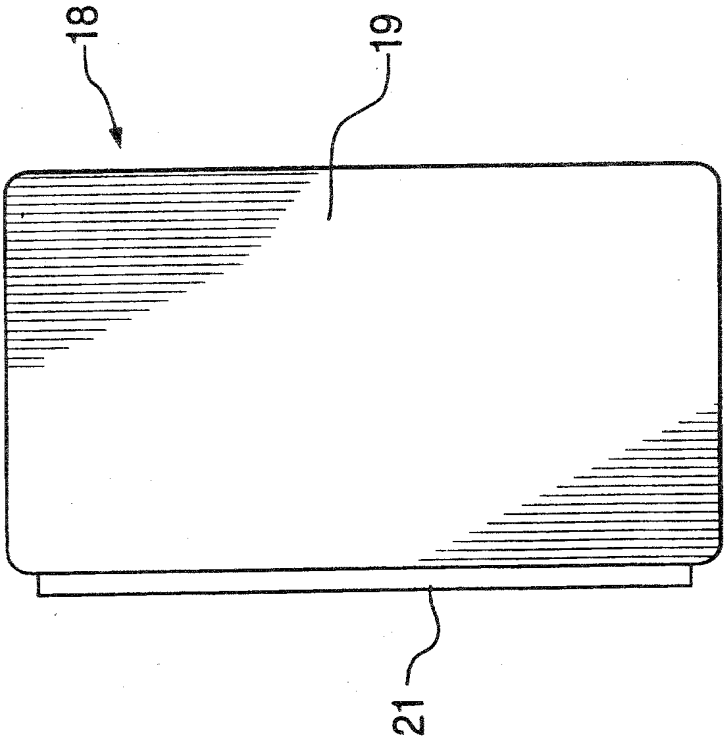

FIG.6

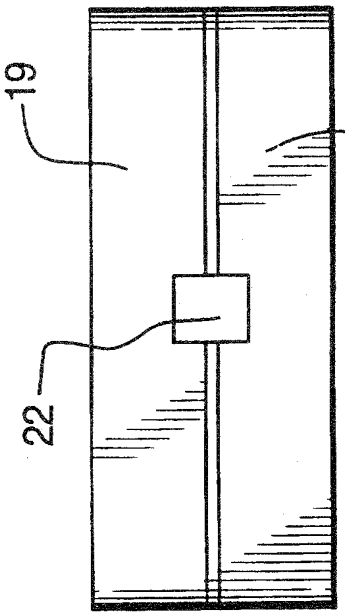

FIG.8

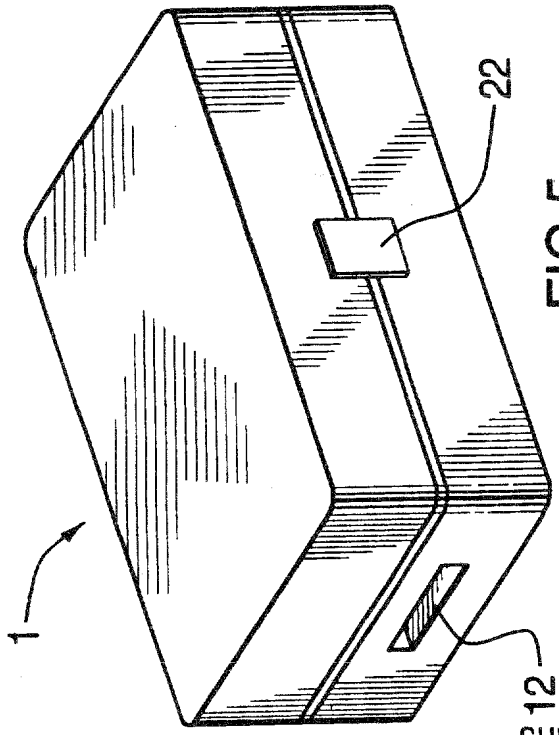

FIG.5

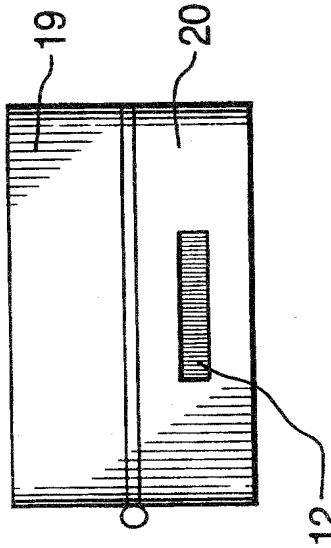

FIG.7

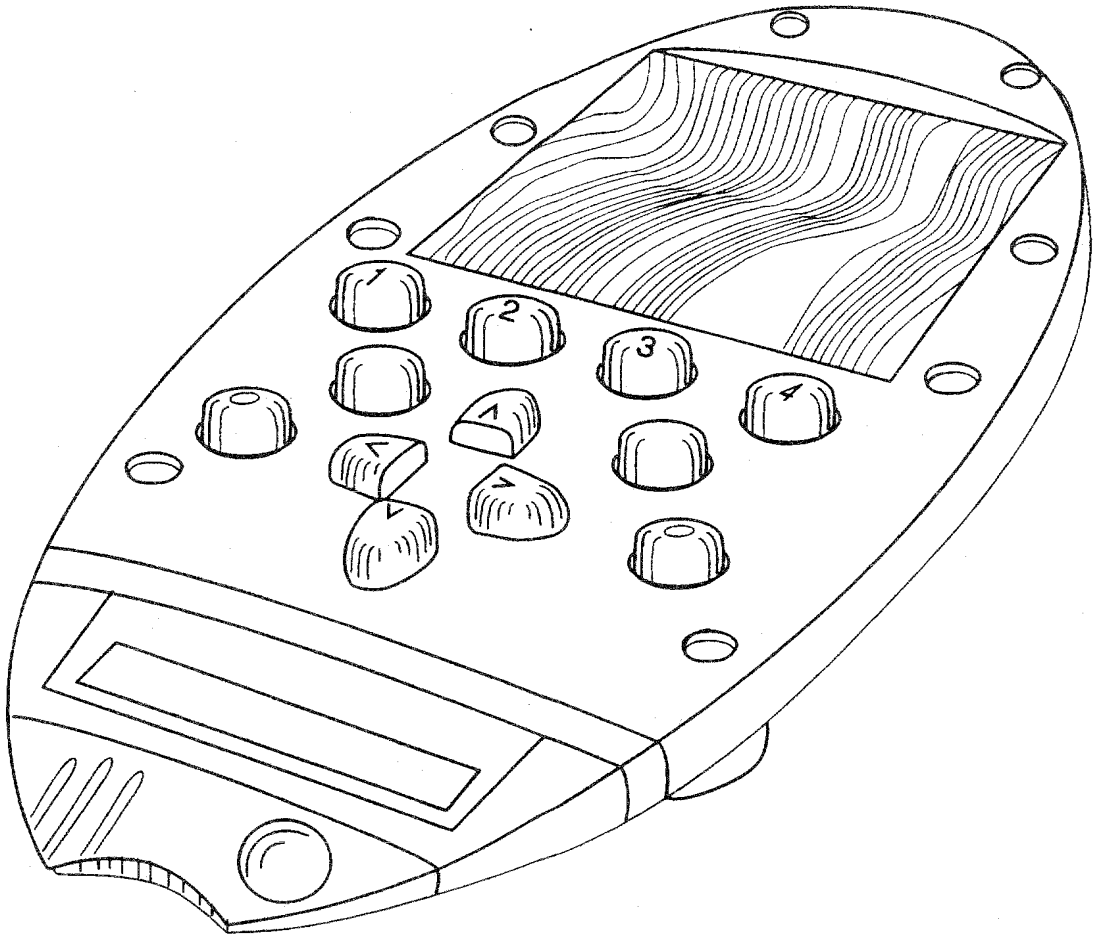

FIG.10

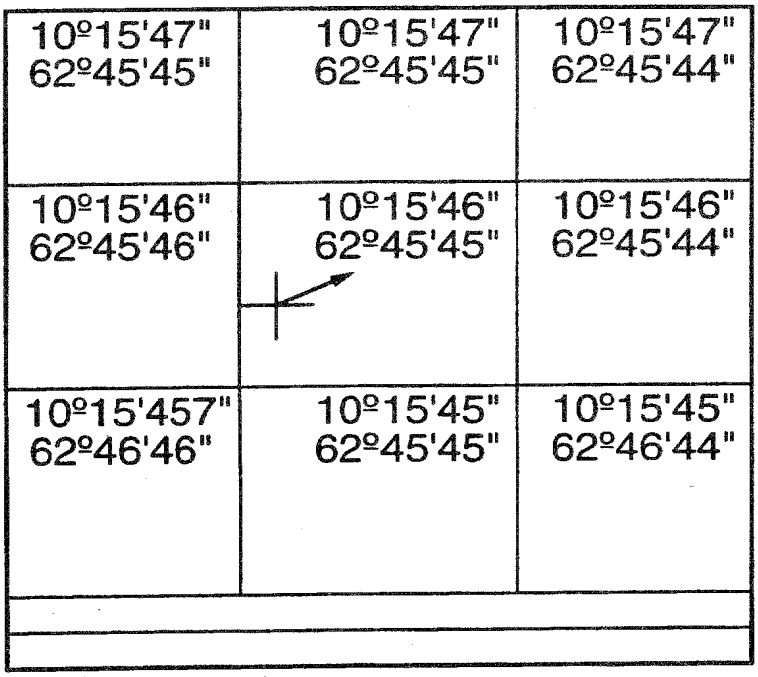

FIG.11

CURRENT LOCATION

Position: 10º15'46"
26º45'45"

Speed: 5 km/h
Direction: 83º

Destination

Position: 10º18'23"
26º45'47"

Speed: 3 km/h
Direction: 79º

FIG.12

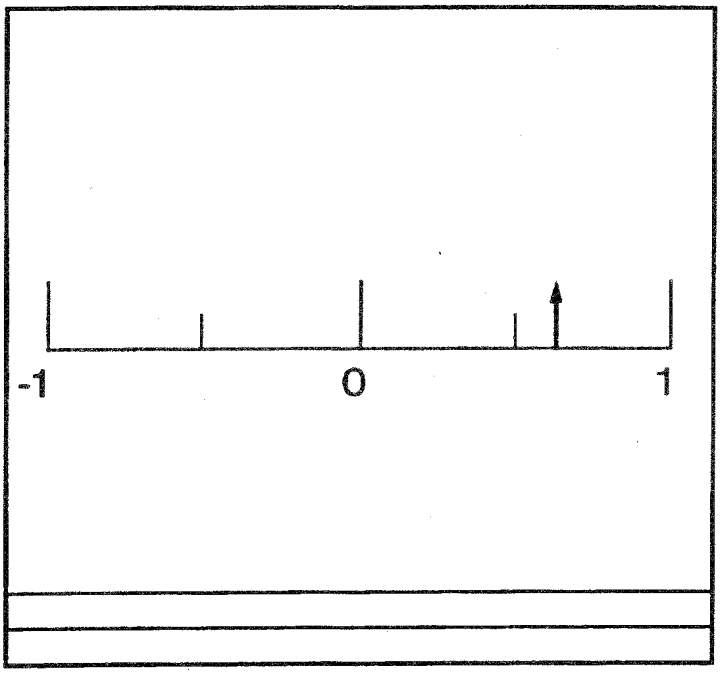

FIG.13

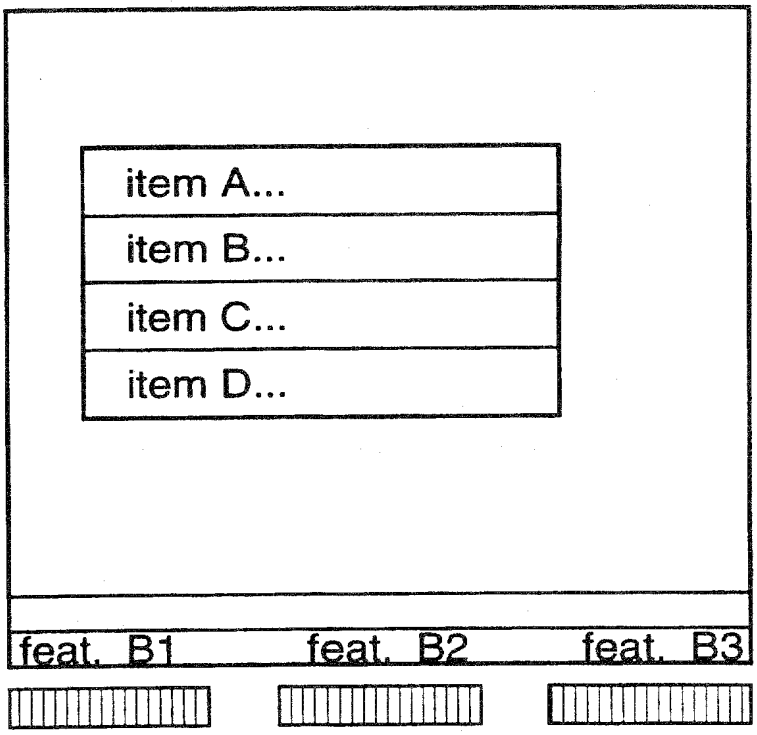

FIG.14

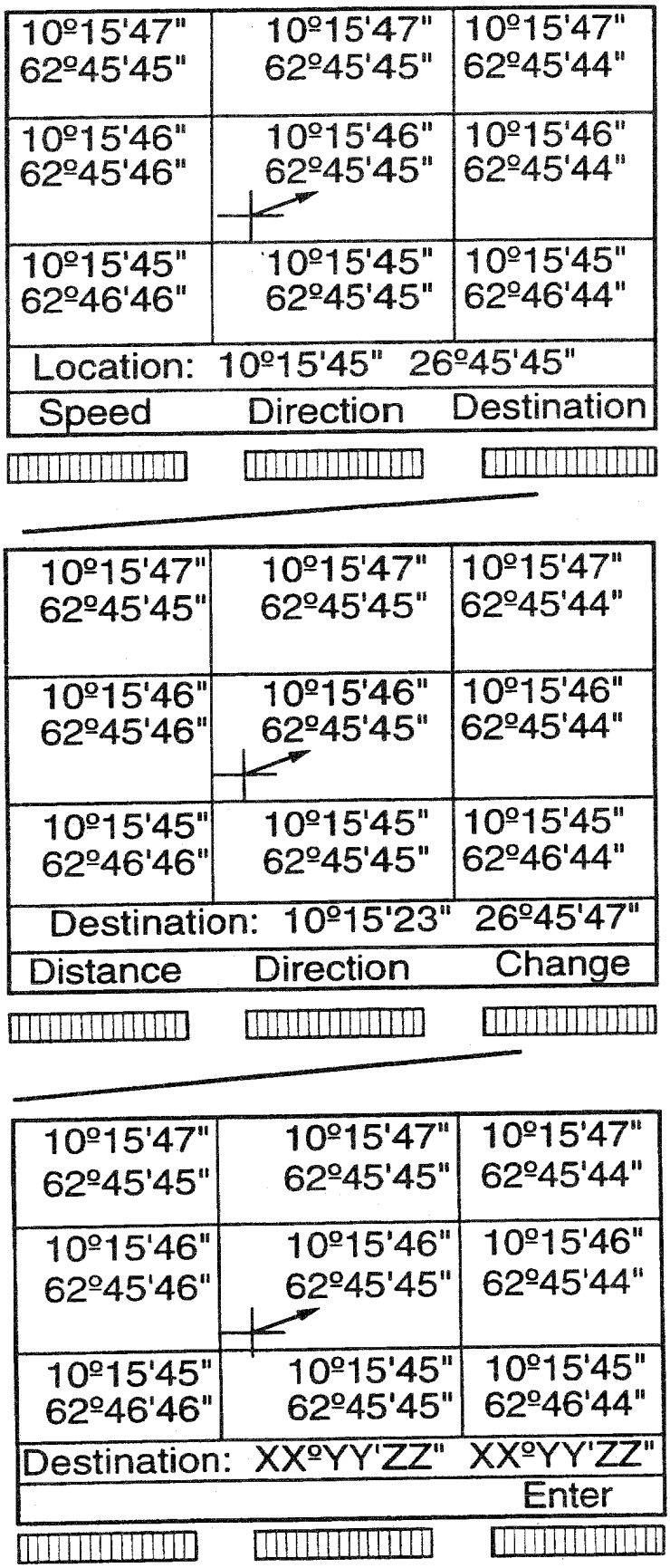

FIG.15

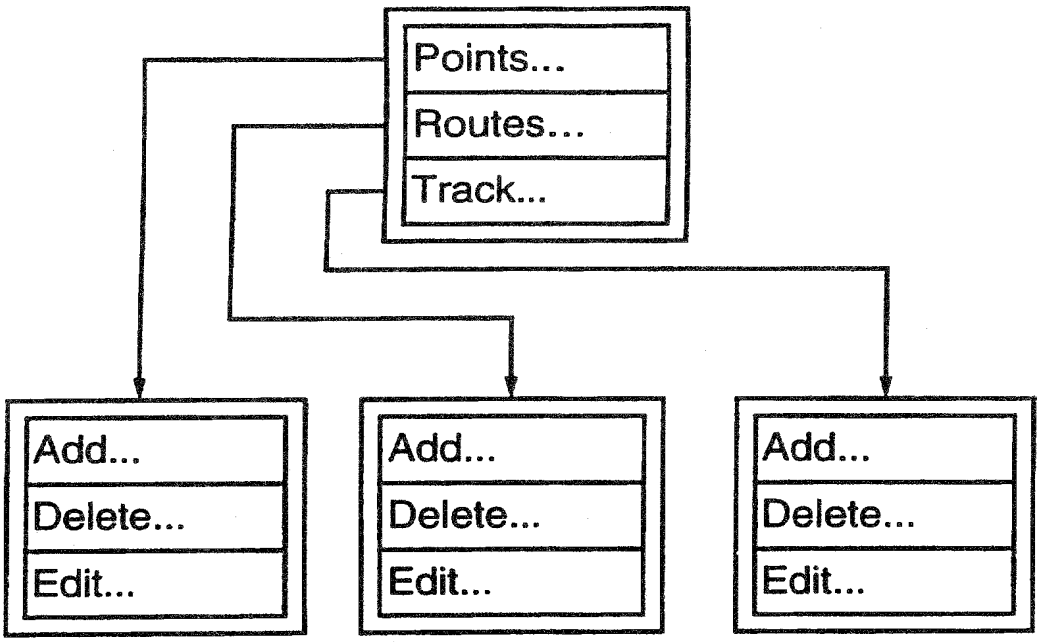

FIG.16

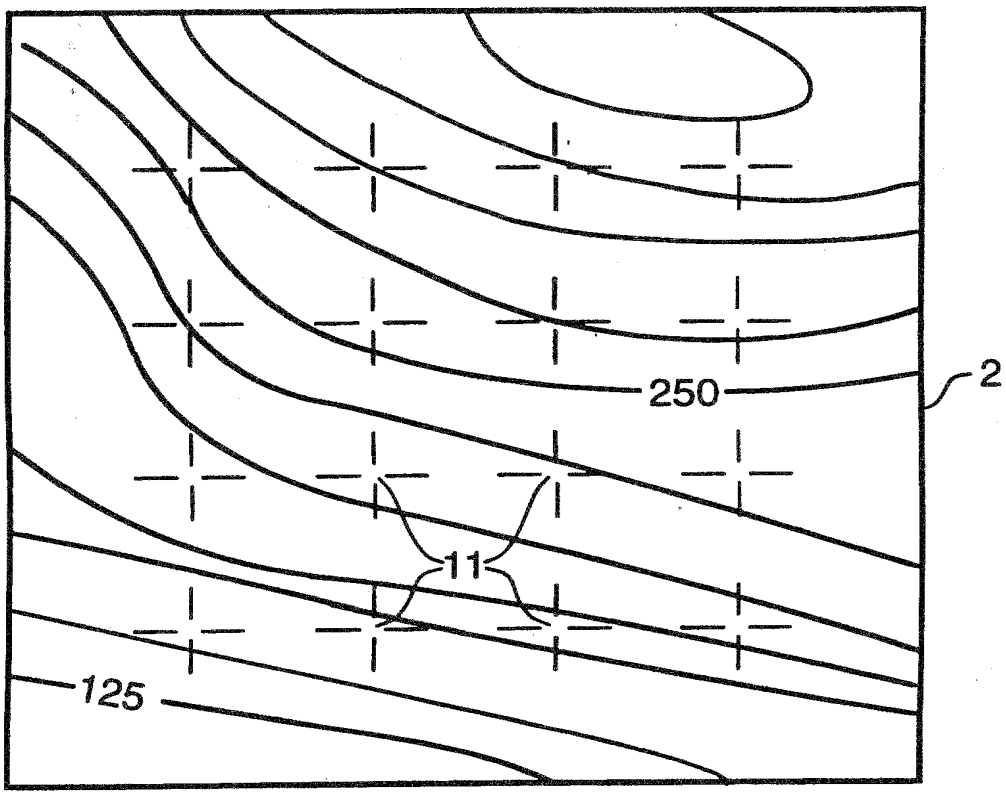

FIG.9

INTERNATIONAL SEARCH REPORT

Inter nal Application No
PCT/CA 95/00627

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 G01C21/20 G01S5/14

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 G01C G01S

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y	WO,A,93 09401 (BERTRAND GEORGES) 13 May 1993 see the whole document	1-3 4
Y	DE,A,42 04 164 (DEUTSCHE AEROSPACE) 19 August 1993 see page 2, column 50 - column 67	4
X	DE,U,93 14 826 (PIETZSCH IBP GMBH) 5 January 1994 see the whole document	1-3
A	WO,A,93 05474 (MOTOROLA INC) 18 March 1993 see abstract	1

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

* Special categories of cited documents :

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
25 January 1996	06.03.96

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+ 31-70) 340-2040, Tx. 31 651 epo nl, Fax (+ 31-70) 340-3016	Hoekstra, F

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INTERNATIONAL SEARCH REPORT

information on patent family members

Inter nal Application No
PCT/CA 95/00627

Patent document cited in search report	Publication date	Patent family member(s)		Publication date
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